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(54) **Arrangement of nozzles with negative pressure for the treatment of webs.**

(57) Arrangement of nozzles with negative pressure intended for the treatment of webs, comprising a nozzle (50), which directs a drying and supporting gas flow (S_1) at the web (W) and which has a box construction, and a nozzle space (55) formed at one side of the nozzle (50), which nozzle space (55) is provided with a nozzle slot (R_1) defined by nozzle walls (56b,A_1), one of which walls operates as a curved guide face (A_1), which is fitted to turn the gas flow (S_1) passed out of the nozzle slot (R_1), based on the Coanda effect, so as to make it parallel to the carrier face (KP_1) formed on the top face of the nozzle (50). At a distance, in the direction of running of the web (W), before said first nozzle slot (R_1), at least one second nozzle slot (R_2) is provided and, in view of improving the heat transfer coefficient, the flow (S_2) guiding fitted in connection with the second nozzle slot (R_2) is arranged so that the flow (S_2) has a substantially large velocity component (v_p) perpendicular to the direction of running of the web (W). The velocity component (v_s) parallel to the plane of running of the web (W) of the flow (S_2) passed out of the second nozzle slot (R_2) is larger than zero.

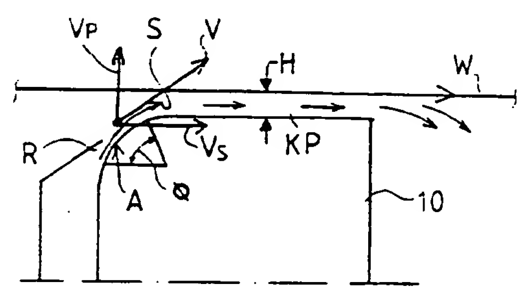

FIG. A1
PRIOR ART

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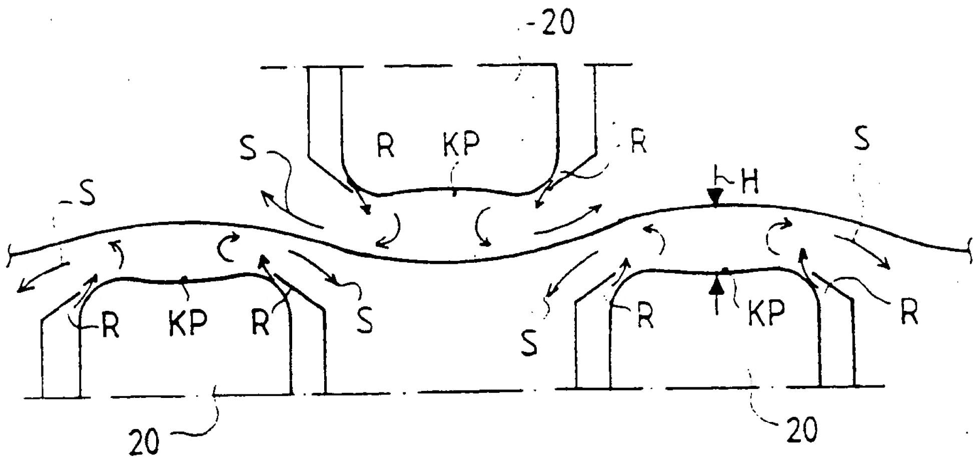


FIG. B1
PRIOR ART

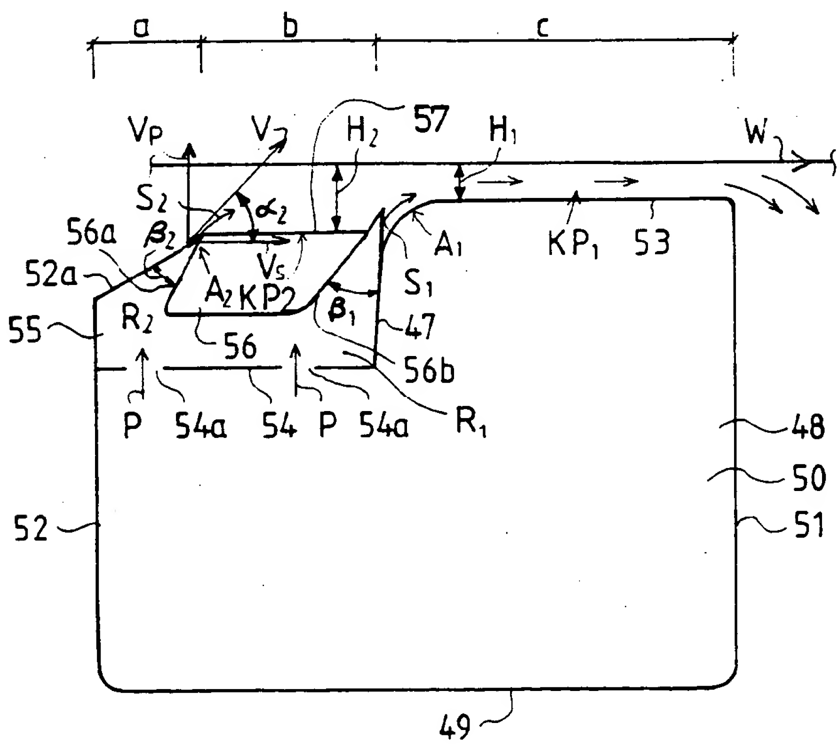


FIG.1

The invention concerns an arrangement of nozzles with negative pressure intended for the treatment of webs, comprising a nozzle, which directs a drying and supporting gas flow at the web and which has a box construction, and a nozzle space formed at one side of the nozzle, which nozzle space is provided with a nozzle slot defined by nozzle walls, one of which walls operates as a curved guide face, which is fitted to turn the gas flow passed out of the nozzle slot, based on the Coanda effect, so as to make it parallel to the carrier face formed on the top face of the nozzle.

Further, the invention concerns a method in an arrangement of nozzles with negative pressure intended for the treatment of webs, in which method the web is supported and dried by means of a gas flow which is blown so that the gas flow turns and becomes parallel to the direction of running of the web.

The nozzle arrangement subject of the invention is intended for contact-free support and treatment, such as drying or heat treatment, of paper webs and other continuous webs. The nozzle arrangement subject of the invention is particularly well suitable for use for contact-free support and drying applications of undried, coated web. The nozzle arrangement subject of the invention is intended for use, e.g., in an airborne web dryer, in which such nozzle arrangements are placed either at both sides of the web or at one side of the web only and in which air is blown through the nozzles to support, to dry, or to heat the web.

Devices based on blowing of gas are employed commonly in the manufacture and refining of paper. In said devices, the gas that is blown is passed by means of various nozzle arrangements to one side or both sides of the web, whereupon the treatment gas is sucked off for renewed use or for removal, and/or the treatment gas is allowed to be discharged to the sides of the web.

The prior-art devices based on contact-free treatment of a web consist of a number of nozzle boxes, out of whose nozzles a gas flow that supports and dries the web is applied to the web. The prior-art nozzles in said devices can be divided into two groups: nozzles with pressure and nozzles with negative pressure, the operation of the pressure nozzle being based on the principle of air cushion, whereas the nozzles with negative pressure produce a dynamic field of negative pressure, and their carrier face attracts the web and stabilizes the run of the web. As is well known, the attractive force applied to the web is based on a gas flow field parallel to the web, which field forms a dynamic negative pressure between the web and the carrier face of the nozzle. Both in the pressure nozzles and in the nozzles with negative pressure, the socalled Coanda effect is commonly utilized to guide the air in the desired direction.

In the pressure nozzles, in a way known in prior art, an area with positive pressure is formed between the web and the carrier face of the nozzle, which pressure attempts to push the web apart from the nozzle, as is shown in Fig. B1. Thus, nozzles with negative pressure must always be placed at both sides of the web, whereby the pushing forces compensate for each other and the web runs approximately at the middle. The pushing force, repulsion, applied to the web at a pressure nozzle is at all distances higher than, or equal to, 0. Fig. B2 illustrates the pushing force produced by such a prior-art pressure nozzle and applied to the web as a function of the distance between the web and the nozzle.

At a nozzle with negative pressure, between the nozzle and the web, an area with a slight negative pressure is formed, which stabilizes the web at a certain distance from the carrier face. The formation of the negative pressure results from the mode of blowing of the air, in which the air jet is guided to run as parallel to the carrier face and to the web, as comes out from Fig. A1 in the drawing. At very short distances between the carrier face of the nozzle and the web, a pushing force is applied to the web, at longer distances an attractive force. Fig. A2 illustrates the attractive/pushing force applied to the web in connection with a prior-art nozzle with negative pressure as a function of the distance between the web and the nozzle.

The force applied by pressure nozzles to the web is relatively high. Thus, by means of pressure nozzles, it is possible to treat heavy and fully non-stretching webs. Most of the prior-art nozzles with positive pressure, however, apply sharp jets substantially perpendicularly to the web, thereby producing an uneven distribution of the heat transfer coefficient in the longitudinal direction, which frequently causes damage to the quality of the web that is treated.

The force applied to the web by the prior-art nozzles with negative pressure is relatively low, for which reason these nozzles are, as a rule, not employed for the treatment of heavy webs or when the tension of the web is low. Thus, nozzles with negative pressure are, as a rule, employed in devices whose length does exceed 5 m and at whose both sides guide rolls are placed to support the web.

In respect of the prior art connected with and closely related to the present invention, reference is made to the FI Patents Nos. 60,261, 68,723, and 77,708 as well as to D.W. Mc Glaughlin, I. Greber, The American Society of Mechanical Engineers, Advances,in Fluids 1976, "Experiments on the Separation of a Fluid Jet from a Curved Surface", pages 14...29. Among these publications, the patents 60,261 and 77,708 describe pressure nozzles, and the FI Patent 68,723 describes a nozzle for an airborne web dryer by whose means a drying and supporting gas flow with negative pressure is applied to the web to be dried.

In the solution known from the FI Patent 68,723

it has been considered novel that the nozzle slot of the nozzle is placed, in a way in itself known, in the gas flow direction, before the level of the inlet edge of the curved guide face and that, with the occurring gas flow rates, the ratio between the width of the nozzle slot and the curve radius of said guide face has been chosen so that the gas flow is separated from the curved guide face substantially before its trailing edge. In said prior-art solution, the nozzle comprises a nozzle box, at one of whose sides there is a nozzle slot, which is defined by the front plate of the flow, on one hand, and by the front wall of the nozzle chamber, on the other hand, going on as a curved flow guide face and further as a deck part.

The cited paper "Experiments on the Separation of a Fluid Jet from a Curved Surface" examines the mechanisms of separation of a flow jet from a curved wall and the various parameters affecting same. With regard to the present invention, those results are relevant that come out from the graphic presentation in Fig. 5 on page 21 of said paper, in which presentation a cluster of curves is shown in a system of coordinates, in which the vertical axis represents the angle of separation and the horizontal axis represents the Reynolds number. The parameter of the cluster of curves is the ratio W/R = ratio of the width of the nozzle slot to the curve radius of the face. It comes out from these study results that, with the flow parameters occurring in the nozzle constructions, the follow angle ø is, as a rule, in the range of 45...70°.

The objective of the operation of the nozzle with negative pressure subject of the invention is to provide a gas flow field which is parallel to the web, which attracts the web, and which stabilizes the run of the web at a certain distance from the carrier face of the nozzle. In a gas flow produced by a nozzle with negative pressure, the transfer of heat in the longitudinal direction of the web is even, so that the nozzles with negative pressure are also suitable for the treatment of sensitive materials. Likewise, they can be used for one-sided treatment of a web.

The object of the invention is in particular to provide a nozzle with negative pressure by whose means an increased heat transfer capacity and an improved conduct of the web are obtained, as compared with the prior-art nozzles, when the quantity of air used per unit of area of the web and the blower power are equal.

In view of achieving the objectives stated above and those that will come out later, the arrangement of nozzles with negative pressure in accordance with the invention is mainly characterized in that at a distance, in the direction of running of the web, before said first nozzle slot, at least one second nozzle slot is provided, and that, in view of improving the heat transfer coefficient, the flow guiding fitted in connection with the second nozzle slot is arranged so that the flow has a substantially large velocity component perpendicular to the direction of running of the web, and that the velocity component parallel to the plane of running of the web of the flow passed out of the second nozzle slot is larger than zero.

The method in accordance with the invention is mainly characterized in that, besides by means of said first gas flow, the web is also supported and dried by means of at least one second gas flow, which is blown, in the direction of running of the web, before the first gas flow, and that the second gas flow is directed so that said second flow has a substantially large velocity component perpendicular to the direction of running of the web and that the velocity component parallel to the direction of running of the web is larger than zero.

Further advantageous characteristic features of the invention are stated in the patent claims 2 to 9.

The inventive solution is based on a novel geometric design of the nozzle and on a novel principle of air blowing.

In the arrangement in accordance with the invention, the drying and supporting gas flow is blown out of the nozzle slots as two flows, of which the latter one, in the direction of running of the web, is turned, because of the Coanda effect, parallel to the carrier face, whereas the other one is directed at a suitable angle in relation to the carrier face, so that the flow does not follow the carrier face but is directed towards the web, whereby a more efficient transfer of heat is obtained. The guide face of said other air flow is not curved, in which case the jet is separated from the carrier face more readily. Further, in the arrangement in accordance with the invention, it is preferable that the distance of the former carrier face, in the direction of running of the web, from the web is slightly larger than the distance of the latter carrier face, in the direction of running of the web, and hereby it is prevented that the flow directed towards the web should push the web further apart from the nozzle.

In the following, the invention will be described in detail with reference to some exemplifying embodiments of the invention illustrated in the figures in the accompanying drawing, the invention being, however, not supposed to be strictly confined to said exemplifying embodiments.

Figure A1 is a schematic illustration of a prior-art nozzle with negative pressure.

Figure A2 shows the attracting/pushing force applied to the web as a function of the distance between the carrier face of a prior-art nozzle with negative pressure and the web.

Figure B1 is a schematic illustration of a prior-art nozzle with positive pressure.

Figure B2 shows the pushing force obtained with a prior-art nozzle with positive pressure as a function of the distance between the web and the carrier face of the nozzle.

Figure 1 is a schematic illustration of an exempli-

fying embodiment of the nozzle arrangement in accordance with the invention.

Figure 2 shows the heat transfer capacity of a nozzle in accordance with the invention as a function of the distance between the carrier face of the nozzle and the web as compared with the corresponding capacity of a prior-art nozzle.

Figure 3 shows the intensities of a sine wave measured for a nozzle in accordance with the invention and for a prior-art nozzle as a function of the web tension.

Figure 4 shows the intensities of a sine wave measured for a nozzle in accordance with the invention and for a prior-art nozzle as a function of the blow speed.

Figure 5 shows an exemplifying embodiment of a solution of the area of the nozzle openings in an arrangement of nozzles with negative pressure in accordance with the invention.

Figure 6 shows a second exemplifying embodiment of the area of the nozzle openings in an arrangement of nozzles with negative pressure in accordance with the invention.

Figure 7 is a schematic illustration of principle of the field of nozzles and the run of the web achieved by means of a nozzle in accordance with the invention.

Figure 8 is a schematic illustration of a two-sided airborne web dryer provided with nozzles with negative pressure in accordance with the invention.

Figure 9 is a schematic sectional view A through Fig. 8, i.e. a sectional view seen in the running direction of the web.

Fig. A1 is a schematic illustration of principle of a prior-art nozzle with negative pressure. The carrier face KP of the nozzle 10 with negative pressure guides the air flow S which is discharged from the nozzle slot R of the nozzle 10 with negative pressure. The distance between the web W and the carrier face KP of the nozzle 10 is denoted with the reference H. Between the nozzle 10 with negative pressure and the web W, an area of slight negative pressure is formed, which stabilizes the web W at a certain distance, e.g. at about 5...8 mm, from the carrier face KP. The formation of the negative pressure is a consequence of the mode of blowing of the air, in which the air jet S is guided to run as parallel to the carrier face KP and to the web W. At very short distances between the nozzle 10 and the web W, a pushing force is applied to the web W, and at larger distances H an attracting force, which comes out from Fig. A2. Fig. A2 illustrates the attracting/pushing force F applied to the web W as a function of the distance H between the nozzle and the web W. The attracting force is represented by the negative portion of the function and the pushing force by the positive portion.

As is shown in Fig. A1, based on the Coanda effect, the flow S discharged from the nozzle slot R follows the curved guide face A on the sector ø, which varies within the range of 45°...70°, in accordance with what was stated above. The flow is separated from the curved guide face A if the velocity vector v of the flow has a remarkably large velocity component v_p perpendicular to the web W (not shown in the figure). Of course, if the angle ø is larger than 45°, the velocity component v_s parallel to the web W of the flow is larger than the velocity component v_p perpendicular to the web.

Figs. B1-B2 are schematic illustrations of a prior-art solution of a nozzle with positive pressure, Fig. B1, and of the force F produced by such a nozzle and applied to the web W as a function of the distance H between the web W and the carrier face KP of the nozzle, Fig. B2. In the nozzle 20 with positive pressure, an area with positive pressure is formed between the web W and the carrier face KP of the nozzle 20, which area attempts to push the web W apart from the nozzle 20. Thus, nozzles 20 with positive pressure must always be placed at both sides of the web W, in which case the pushing forces compensate for each other and the web W runs approximately in the middle. At a nozzle 20 with positive pressure, the force applied to the web is at all distances higher than 0, as comes out from Fig. B2, i.e. a pushing force is applied to the web W.

Fig. 1 is a schematic illustration of a nozzle 50, which has a box construction. The box construction consists of a rear wall 51, a bottom wall 49, a top wait 53, and a front wall 52. On the top face of the top wall 53, a carrier face KP_1 is formed. In the interior of the nozzle 50, a chamber 48 is formed, in which a nozzle space 55 has been defined by means of partition walls, for example a partition wall 54 parallel to the bottom wall 49 and a partition wall 47 parallel to the rear and front walls 51,52. The drying gas is passed into the chamber 48. The drying gas is passed out of the chamber 48 as a flow P into the nozzle space 55, for example, through openings 54a made into the partition wall 54 parallel to the bottom wall 49 of the nozzle space 55. In the exemplifying embodiment as shown in Fig. 1, nozzle slots R_1 and R_2 have been formed in the nozzle space 55 so that the nozzle walls A_1;56b of the first nozzle slot R_1 are formed of the guide face A_1 connected with the partition wall 47 in the chamber 48 and of the rear wall 56b of the intermediate piece 56 in the nozzle space 55, and the nozzle walls 52a,56a of the second nozzle slot R_2 are formed of the extension 52a of the front wall 52 of the chamber 48 and of the front wall 56a of the intermediate piece 56. For the purpose of formation of the nozzle walls 56a,56b, between the nozzle slots R_1,R_2 in the nozzle space 55 there is an intermediate piece 56, which comprises a rear wall 56b, a front wall 56a, and a top wall 57, on whose top face the carrier face KP_2 is formed.

The nozzle slot R_1 becomes narrower in the run-

ning direction of the drying gas flow S_1 so that the narrowest point is placed at the outlet opening. The narrowing angle β_1 is 10°...40°, preferably about 30°. The narrowing angle β_2 of the nozzle slot R_2 is 20°...50°, preferably 30°...40°.

The first nozzle slot R_1 and the second nozzle slot R_2 are placed at a distance from one another substantially at the same side of the nozzle 50 at the side of the inlet direction of the web W. In the direction of running of the web W, the second nozzle slot R_2 is placed before the first nozzle slot R_1. Out of the nozzle slot R_1, the gas flow is discharged, being guided by the curved guide face A_1, into the space between the web W and the nozzle 50 and, based on the Coanda effect, turns and becomes parallel to the first carrier face KP_1. The air from the nozzle slot R_2 is guided as a flow S_2 towards the web W, whereby a higher heat transfer coefficient is obtained than by turning the flow so that it becomes parallel to the carrier face KP_2. The velocity component v_p perpendicular to the direction of the web W of the drying-gas flow S_2 discharged out of the nozzle slot R_2 is sufficiently large in relation to the velocity component v_s parallel to the plane of running of the web W of the flow S_2, in which case the flow S_2 does not start following the carrier face KP_2 but is directed towards the web W. The velocity component v_s parallel to the plane of running of the web W is larger than zero. The ratio v_p/v_s of the velocity components v_p and v_s is in the range of 0.4...2.0, preferably in the range of 0.8...1.5; $v_p/v_s = \tan \alpha_2$.

In the arrangement of nozzles with negative pressure in accordance with the invention, drying gas is blown out of the nozzle slots R_1 and R_2. Owing to the Coanda effect, the flow S_1 blown out of the slot R_1 is turned parallel to the carrier face KP_1, and the flow S_2 is blown out of the slot R_2, which flow is directed at a suitable angle α_2 in relation to the carrier face KP_2 so that the flow S_2 does not follow the carrier face KP_2 but is directed towards the web W, whereby a more efficient transfer of heat is achieved. In view of the separation of the flow, it is preferable that the edge A_2, which constitutes an extension of the front wall 56a of the intermediate piece 56 and which acts as a guide face, is not rounded. The angle formed by the edge A_2 is equal to 180° - α_2. Further, it is preferable that the distance H_2 of the carrier face KP_2 from the web W is slightly larger than the distance H_1 of the carrier face KP_1 from the web W in order that the flow S_2 should not push the web W further apart from the nozzle.

The dimensional proportions of the nozzle 50 denoted in Fig. 1 are, for example, of such an order of magnitude that the distance a of the second nozzle slot R_2 from the front wall 52 of the nozzle 50 is 20 mm, the distance b between the nozzle slots R_1 and R_2 is 30 mm, the distance c of the first nozzle slot R_1 from the rear wall 51 of the nozzle 50 is 60 mm, the width of the nozzle slot R_1 is 2 mm, and the width of the nozzle slot R_2 is 1 mm. If necessary, the nozzle 50 can also be manufactured on different scales so that the dimensions given above are multiplied, e.g., by a scale factor 0.5...2.5, preferably 0.8...2.0. The blow velocity employed in the nozzle 50 in each nozzle slot R_1 and R_2 is preferably of an order of 30...60 m/s. The distance H_1 of the carrier face KP_1 from the web W is 3...10 mm, preferably 4...7 mm, and the distance H_2 of the carrier face KP_2 from the web W is 6...15 mm, preferably 7...11 mm.

In addition to the above, the nozzle 50 can be designed, e.g., so that for each nozzle slot R_1,R_2 a nozzle space 55 of its own is formed in the nozzle 50.

Fig. 2 illustrates the heat transfer capacity of an arrangement of nozzles with negative pressure in accordance with the invention as compared with a prior art nozzle of corresponding type in an example test. The heat transfer coefficient a obtained by means of the solution of the invention as a function of the distance H between the nozzle and the web is illustrated by the solid line, and the heat transfer factor a of the prior-art nozzle as a function of the distance between the nozzle and the web by the dashed line. In the test, the following values were used: blow velocity 60 m/s with both nozzles, width of nozzle slot 2.5 mm with the prior-art nozzle and total width of the two nozzle slots of the nozzle of the invention 3.0 mm, spacing of nozzles with the prior-art nozzle 180 mm and with the nozzle of the invention 220 mm, and the air quantity blown with the prior-art nozzle 0.83 $m^3/m^2/s$, and with the nozzle of the invention 0.82 $m^3/m^2/s$. On the vertical axis the heat transfer coefficient a is given as the units $W/m^2/°C$. As comes out from the figure, the nozzle in accordance with the invention is about 10 % more efficient than the nozzles known in prior art.

Fig. 3 illustrates the intensities of the sine wave as a function of the web tension in a test example, measured for the nozzle of the invention (solid line) and for a prior-art nozzle (dashed line). The unit of intensity of the sine wave used has been the height A of the wave as millimetres, and the unit of web tension R_k has been N/m. In said measurement, an LWC-paper was used while the spacing of nozzles was 220 mm, the blow velocity 45 m/s, the distance between the web and the nozzle 6 mm, and the web speed 400 m/min.

Fig. 4 illustrates the intensity of the sine wave as a function of the blow velocity PS for a nozzle of the invention with a solid line and for a prior-art nozzle with a dashed line. The values used in the test were the same as those in the preceding example, while the web tension was 250 N/m. The unit of intensity of the sine wave was the height of the wave as millimetres and the unit of the blow velocity PS was m/s.

In both examples, the nozzle in accordance with the invention provided a clearly stronger sine wave, which also provides a better running quality. In the

runnability test runs carried out, it was noticed that the nozzle in accordance with the invention, as compared with the prior-art nozzle, possessed a stronger sine wave and produced a more stable run of the web and less folds in the machine direction.

Figs. 5 and 6 are schematic illustrations of two exemplifying embodiments of the design of the second carrier face KP_2. Fig. 5 shows an embodiment in which the carrier face KP_2 between the nozzle slots R_1 and R_2 is shaped as a recess, and in Fig. 6 the carrier face KP_2 between the nozzle slots R_1,R_2 is plane. In the exemplifying embodiment as shown in Fig. 5 the intermediate piece 56, which forms the nozzle slots R_1 and R_2 with the walls 47 and 52, respectively, is designed as U-shaped, so that the carrier face KP_2 does not become plane. In respect of the rest of its construction, the embodiment shown in Fig. 5 corresponds to that shown in Fig. 1. In Fig. 6, the intermediate piece 56, which formes the nozzle slots R_1,R_2 with the walls 47 and 52, is closed so that the wall 57 forms a plane carrier face KP_2 on its top face.

Fig. 7 is a schematic illustration of an example of an arrangement of nozzles with negative pressure in accordance with the invention and of the run of the web W when such an arrangement of nozzles with negative pressure is employed. The nozzles 50 are placed at both sides of the web so that the drying-gas flows S_1,S_2 that are blown support the web W evenly. Of course, the nozzles 50 may be placed at one side of the web only, and besides the shape in accordance with Fig. 5, the nozzle 50 may also be, for example, similar to that shown in Fig. 1 or 6.

Fig. 8 is a schematic illustration of a dryer provided with nozzles in accordance with the invention. At both sides of the web W, nozzles 50 are provided, through which drying gas S is blown to support and to dry the web W. The return flow is denoted with the reference arrows Y. The return flow Y returns into the return duct 60. From the inlet duct 65, the drying gas is passed into the nozzles 50. The reference numeral 70 represents the frame constructions of the dryer.

Fig. 9 is a sectional view of the dryer as seen in the direction of running of the web W, said view being the section A denoted in Fig. 8. From the distribution box 62, the drying gas is passed both to the upper boxes and to the lower boxes of the airborne web dryer. The inlet ducts 65 communicate with the distribution box 62 for intake air, which is placed at the side of the dryer, through resilient connectors 61. In a corresponding way, the exhaust ducts communicate with the distribution box for exhaust air through resilient connectors. The resilient connectors and the distribution boxes are air ducts, and the dryer is supported on the frame separately by means of other devices (not shown). From the inlet duct 65 the drying gas is passed through the distribution ducts 67 into the nozzles 50, from which the drying gas is blown further to support and to dry the web W.

Even though, in Figs. 7, 8 and 9, nozzles 50 are shown as placed at both sides of the web W, it should be emphasized that the nozzle construction in accordance with the invention can also be applied to airborne web dryers in which nozzles 50 are placed at one side of the web W only.

In the solution in accordance with the invention, besides in the way shown in the figures, the second nozzle slot R_2 may also be shaped in other ways, for example in accordance with what is shown in Fig. 2 in the FI Patent 68,723. It is essential that the gas flow S_2 does not follow the carrier face KP_2 but is directed at the web W.

In the exemplifying embodiments shown in the figures, the velocity component v_s parallel to the web W running plane is shown as parallel to the running direction of the web W. It is also included in the inventive idea that the running direction of the web may also be opposite to that shown in Fig. 1.

Above, the invention has been described with reference to some preferred exemplifying embodiments of same only. This is, however, in no way supposed to restrict the invention to these embodiments only, but many modifications and variations are possible within the scope of the inventive idea defined in the following claims.

Claims

1. Arrangement of nozzles with negative pressure intended for the treatment of webs, comprising a nozzle (50), which directs a drying and supporting gas flow (S_1) at the web (W) and which has a box construction, and a nozzle space (55) formed at one side of the nozzle (50), which nozzle space (55) is provided with a nozzle slot (R_1) defined by nozzle walls (56b,A_1), one of which walls operates as a curved guide face (A_1), which is fitted to turn the gas flow (S_1) passed out of the nozzle slot (R_1), based on the Coanda effect, so as to make it parallel to the carrier face (KP_1) formed on the top face of the nozzle (50), **characterized** in that at a distance, in the direction of running of the web (W), before said first nozzle slot (R_1), at least one second nozzle slot (R_2) is provided, and that, in view of improving the heat transfer coefficient, the flow (S_2) guiding fitted in connection with the second nozzle slot (R_2) is arranged so that the flow (S_2) has a substantially large velocity component (v_p) perpendicular to the direction of running of the web (W), and that the velocity component (v_s) parallel to the plane of running of the web (W) of the flow (S_2) passed out of the second nozzle slot (R_2) is larger than zero.

2. Arrangement of nozzles with negative pressure as claimed in claim 1, **characterized** in that the

guide face of the drying gas flow (S_2) blown out of the second nozzle slot (R_2) consists of the edge (A_2).

3. Arrangement of nozzles with negative pressure as claimed in claim 1 or 2, **characterized** in that the distance (H_1) between the carrier face (KP_1) formed in connection with the first nozzle slot (R_1) and the web (W) is shorter than the distance (H_2) between the carrier face (KP_2) formed in connection with the second nozzle slot (R_2) and the web (W).

4. Arrangement of nozzles with negative pressure as claimed in any of the claims 1 to 3, **characterized** in that the distance (H_1) between the carrier face (KP_1) formed in connection with the first nozzle slot (R_1) and the web (W) is 3...10 mm, preferably 4...7 mm, and that the distance (H_2) between the carrier face (KP_2) formed in connection with the second nozzle slot (R_2) and the web (W) is 6...15 mm, preferably 7...11 mm.

5. Arrangement of nozzles with negative pressure as claimed in any of the claims 1 to 4, **characterized** in that the second gas flow (S_2) is directed at an angle (α_2) of 40°...70° in relation to the running direction of the web (W).

6. Arrangement of nozzles with negative pressure as claimed in any of the claims 1 to 5, **characterized** in that the second carrier face (KP_2) is shaped as a recess.

7. Arrangement of nozzles with negative pressure as claimed in any of the claims 1 to 5, **characterized** in that the second carrier face (KP_2) is plane.

8. Method in an arrangement of negative pressure intended for the treatment of a web, in which method the web (W) is supported and dried by means of a gas flow (S_1) which is blown so that the gas flow (S_1) turns and becomes parallel to the direction of running of the web (W), **characterized** in that, besides by means of said first gas flow (S_1), the web (W) is also supported and dried by means of at least one second gas flow (S_2), which is blown, in the direction of running of the web (W), before the first gas flow (S_1), and that the second gas flow (S_2) is directed so that said second flow (S_2) has a substantially large velocity component (v_p) perpendicular to the direction of running of the web (W) and that the velocity component (v_s) parallel to the direction of running of the web is larger than zero.

9. Method as claimed in claim 8, **characterized** in that the ratio of the velocity component (v_p) perpendicular to the running direction of the web (W) to the velocity component (v_s) parallel to the running direction of the web (W) is 0.4...2.0, preferably 0.8...1.5.

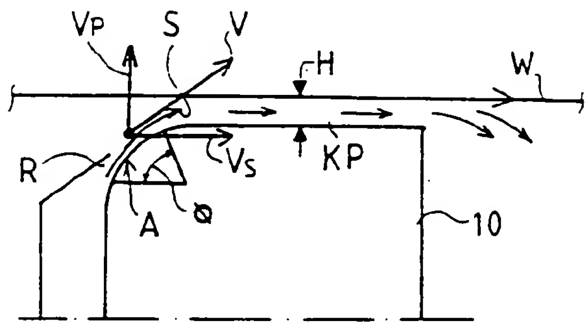


FIG. A1
PRIOR ART

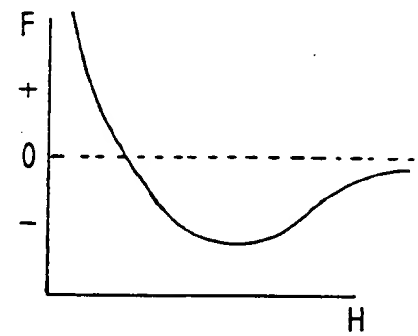


FIG. A2
PRIOR ART

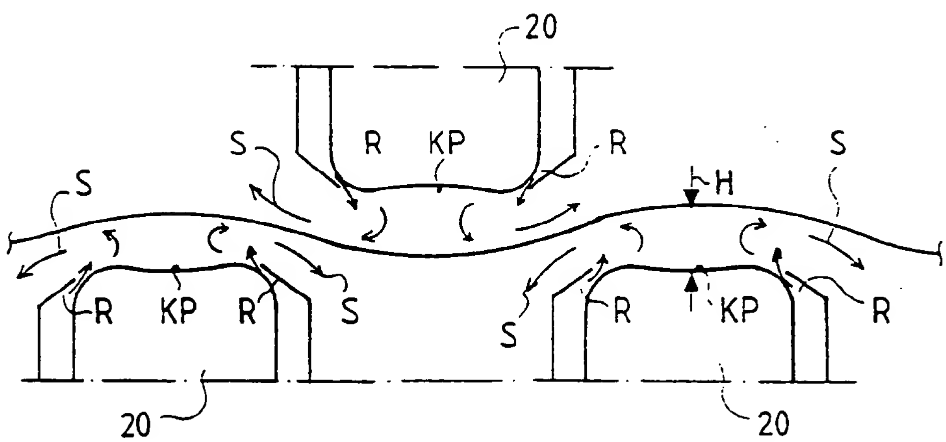
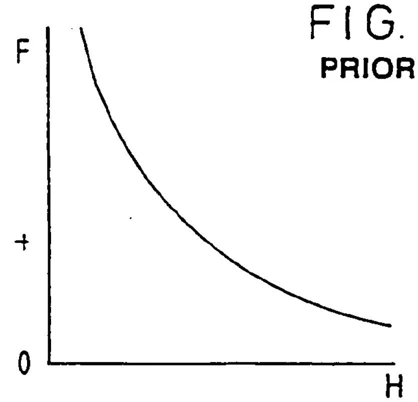


FIG. B1
PRIOR ART

FIG. B2
PRIOR ART



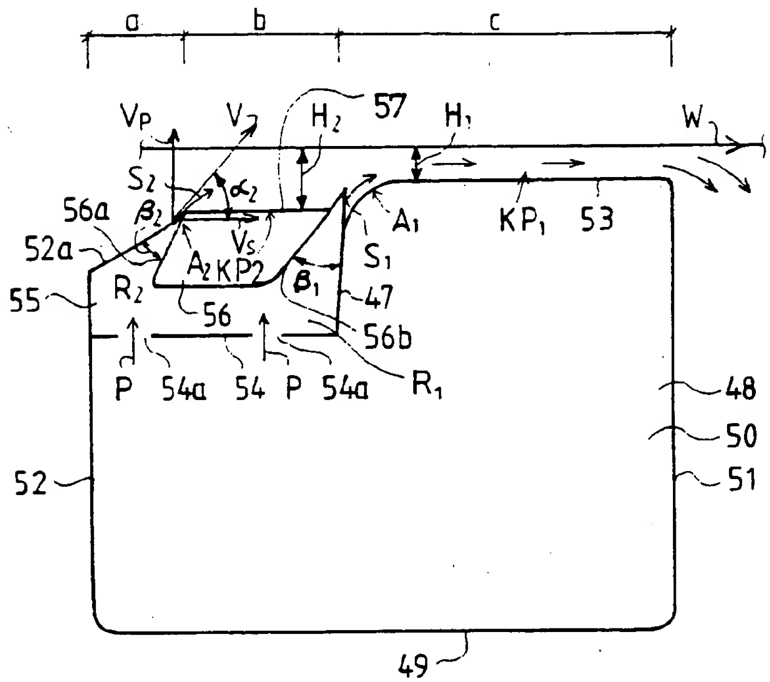

a
b
c
Vp
V2
H2
57
H1
W
S2
α2
56a
β2
Vs
A1
KP1
53
52a
A2
KP2
S1
β1
R2
47
55
56
56b
P
54a
54
P
54a
R1
48
50
52
51
49

FIG.1

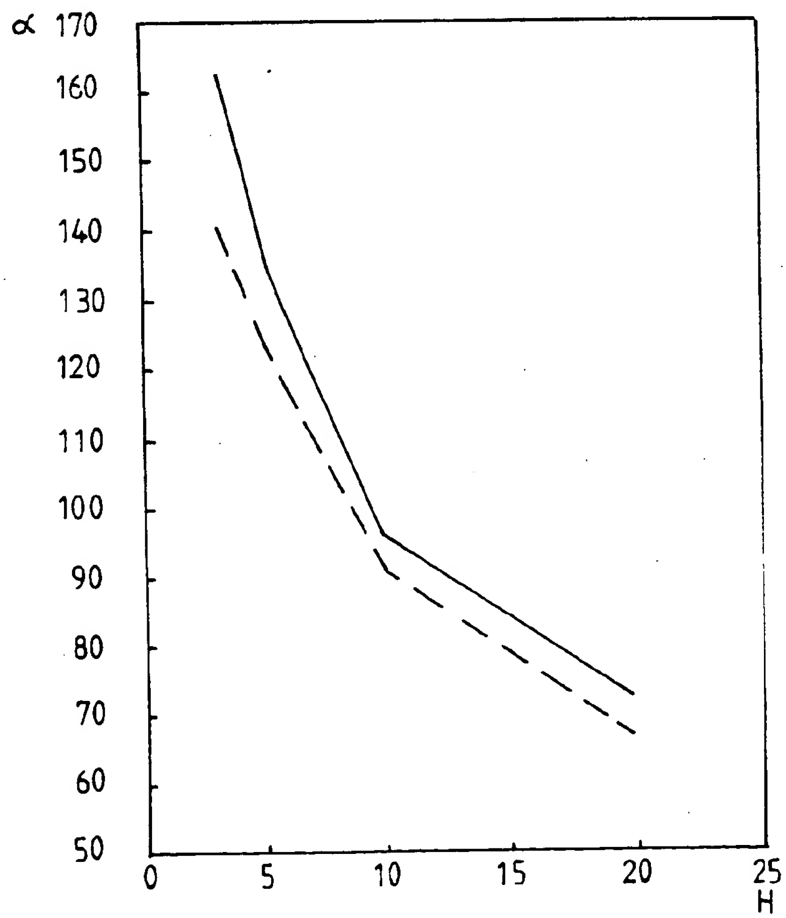

α
170
160
150
140
130
120
110
100
90
80
70
60
50
0
5
10
15
20
25
H

FIG.2

FIG.3

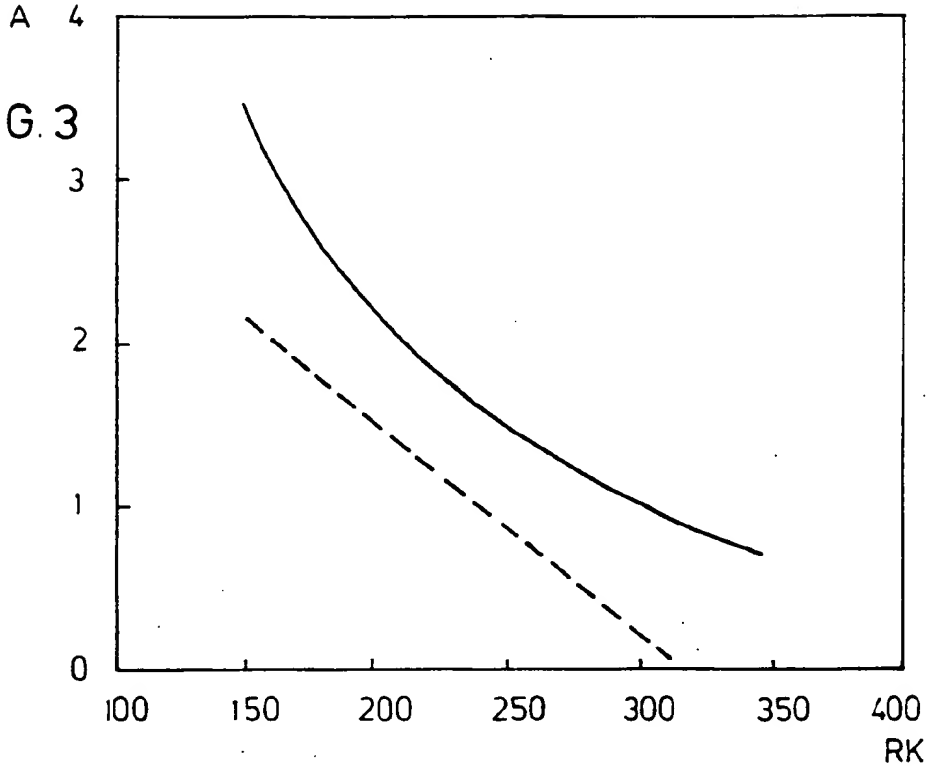
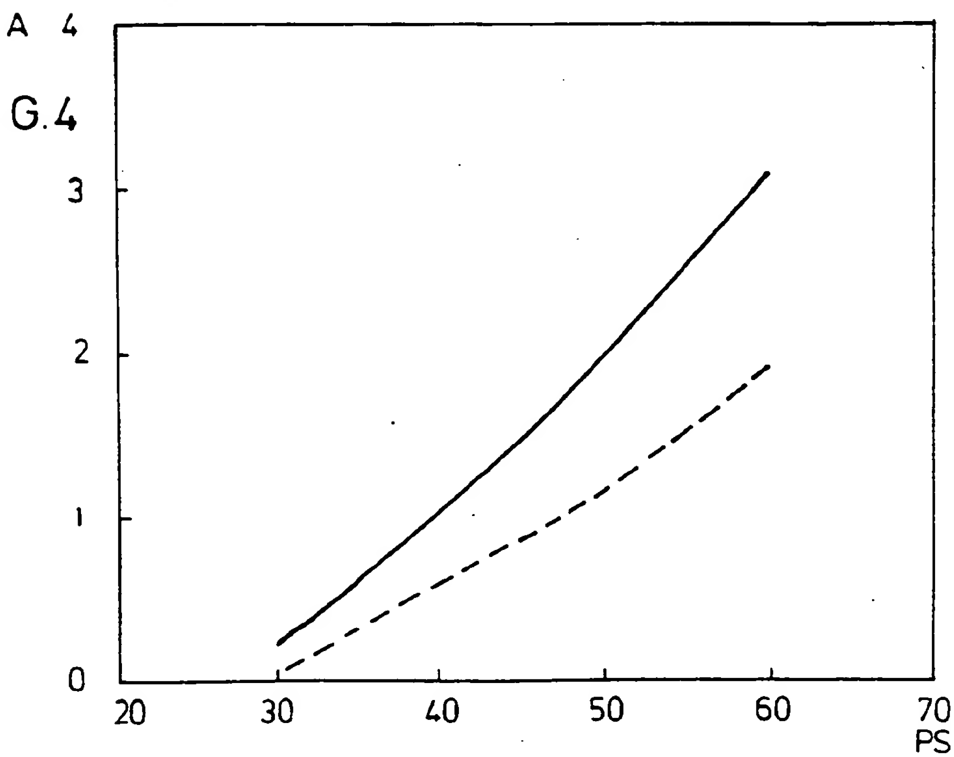


FIG.4



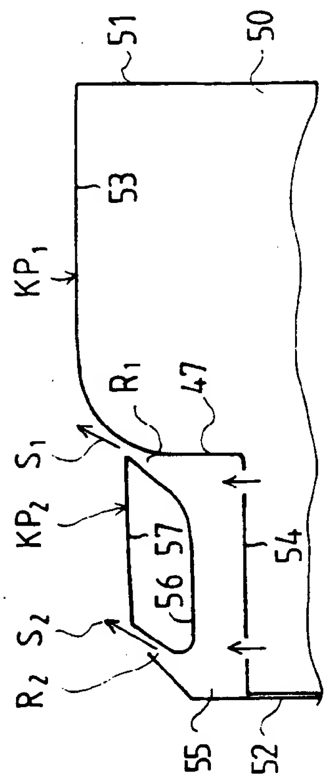


FIG. 6

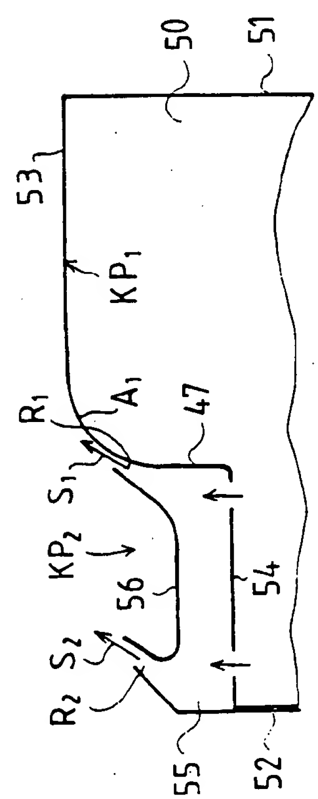


FIG.5

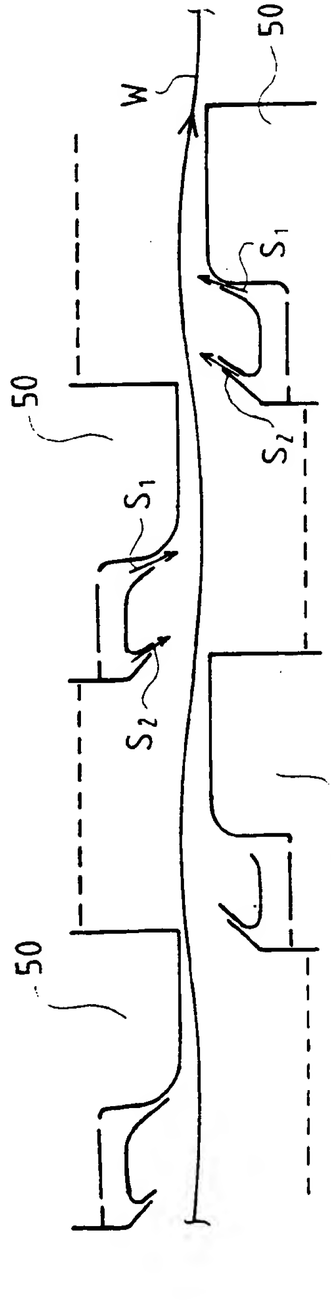


FIG.7

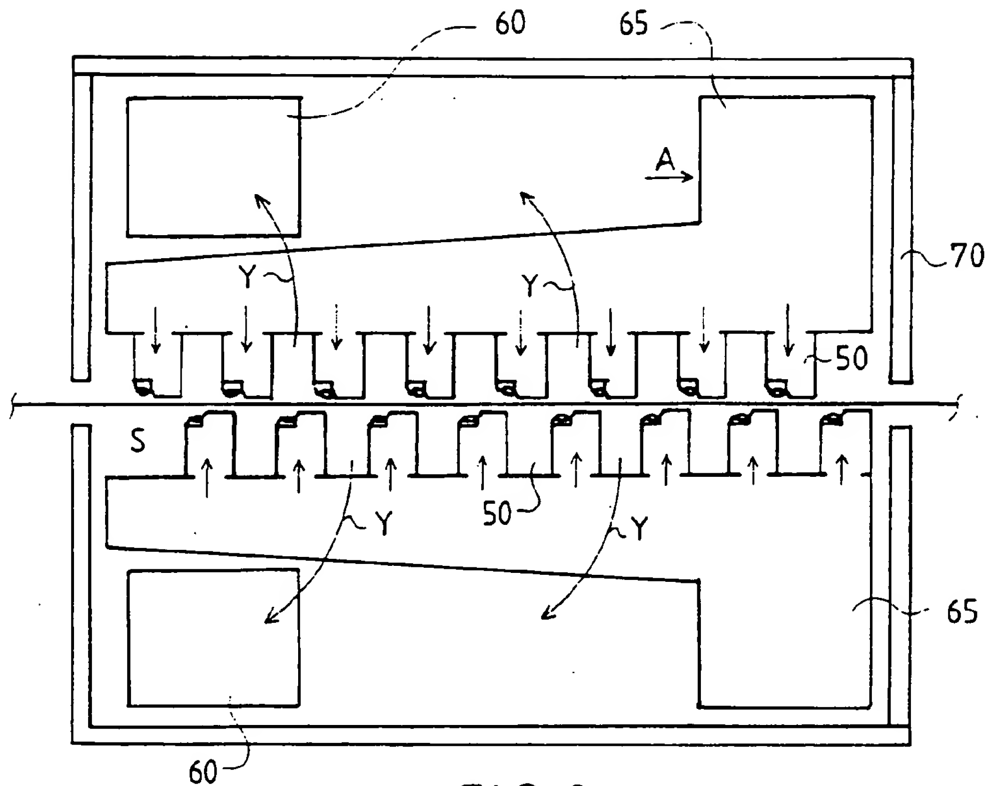


FIG. 8

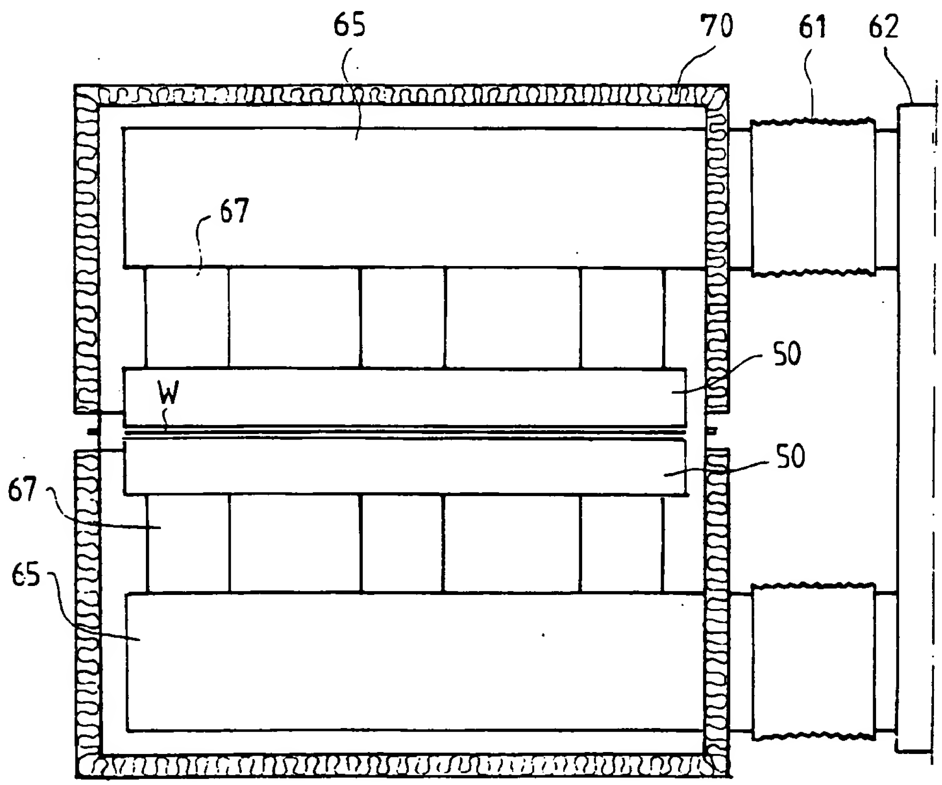


FIG. 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 85 0208

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 196 107 (THERMO ELECTRON-WEB SYSTEMS) * the whole document *	1,5,7	D21F5/18 F26B13/10 B65H23/24
P,X	DE-A-4 111 435 (WORLDWIDE CONVERTING MACHINERY) * the whole document *	1,2,5,7, 8	
A	EP-A-0 012 731 (AB SVENSKA FLÄKTFABIKEN) * the whole document *	1,3,7,8	
A	EP-A-0 298 299 (VITS) * the whole document *	1-3,6,8	
A	EP-A-0 236 819 (THERMO ELECTRON-WEB SYSTEMS) * the whole document *	1,3,6,8	
A	DE-A-1 954 880 (OVERLY)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

D21F
F26B
B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 DECEMBER 1992	DE RIJCK F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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